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VERIFICATION OF TRANSLATION

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am the translator of the English language document attached and I state that the attached document is a true translation of

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METHOD FOR GUIDING AN AUTOMATIC CLEANING DEVICE FOR A SURFACE SUBMERGED IN A LIQUID, AND CORRESPONDING CLEANING DEVICE

The invention relates to a method for guiding an automatic cleaning device for a surface submerged in a liquid, in particular lateral walls and bottom of a swimming pool. Automatic cleaning devices for surfaces submerged in a liquid are already known which include:

- a chassis carrying a device for filtration of the liquid
- units for driving the chassis on the surface to be cleaned
- motors born on the chassis and arranged for transmitting motor movement to at least one part of the drive units
- electronic means for controlling motors according to one or more predetermined cleaning programs adapted for optimizing the length and effectiveness of the cleaning performed.

In particular US patent 4,162,557 describes a cleaning device including reversible electric motors controlled by a random impulse generator which leads to frequent random reversals of the sense of the supply current for these motors.

The US patent 5,507,058 describes a swimming pool cleaning device provided with an inclination detection sensor which is used by the system as a detector of a change of the cleaned surface or as confirmation of a movement already evaluated by the displacement detector. The inclination detector can also be used in order to program, within the control card, specific actions such as changing direction by 90 or 180°.

The US patent 6,299,699 describes a device and method for cleaning a pool; the device is fitted with a sensor which makes it possible to detect a change of inclination in order to evaluate the changes of inclination of the

different walls of the pool and make it possible for the device to recognize the type of walls on which it is moving in order to optimize the cleaning time and/or trajectory.

Another automatic device described in the patent FR 2,567,552 itself comprises, in combination, means for sequential reversal of the sense of the supply current for the electric motors likely to cause periodic reversals of said motors and means for sequential interruption of the supply of the pump's electric motor likely to cause periodic stoppages of said pump.

Further, some of the current devices are designed to increase the cleaning effectiveness in the area of the water line which constitutes an area requiring a specific cleaning. Thus, as an example, the device described in the patent FR 2,567,552 cited above includes a floater and a motor suited and positioned for balancing this device when it is at the level of the water line in a manner to lead to a lateral displacement of said device along this waterline and to favor the cleaning of the latter.

In contrast, there does not currently exist any cleaning device that makes it possible to obtain effective cleaning of the concave junction zones between portions of the submerged surface of different inclinations, such as the base of the lateral walls of the pools. These concave junction zones however constitute areas where dirt accumulates and additionally are less well cleaned than the even portions of the walls because of the device's inclination during its transition between two portions of different inclination (lateral wall and bottom for example).

The present invention aims to remedy this deficiency and its principal objective is to provide a cleaning device suitable for effectively cleaning the junction zones between two portions of submerged surface with different inclinations.

Another objective of the invention is to provide this result with minimal, or even no, material modifications.

For this purpose, the invention targets a method for guiding a cleaning device such as described above additionally comprising an operation which consists of detecting changes of the device's inclination corresponding to its passage over a concave junction zone between two portions of the submerged surface inclined relative to each other.

The method is characterized in that upon the condition of at least one change of the device's inclination being detected, a specific cleaning method for the junction zone is begun and which consists of at least two reversals of the device's drive direction, with at least one reversal on each surface portion, such that the device passes over the concave junction zone from one portion of the submerged surface to the other at least three times.

According to the invention, the cleaning device is therefore designed to perform, during each transition between two surface portions with different inclinations—notably two contiguous walls such as the bottom wall and side wall—at least one specific cleaning method consisting of having said device execute at least one additional back-and-forth movement during which it sweeps the surface of these portions' junction zone at least two additional times.

Consequently the lower effectiveness resulting from the device's inclination during its transition, and the increased distance between the filtration device's lower water inlet and the submerged surface finds itself compensated by a multiplication of the number of sweepings of the junction zone by said device.

At the end of each specific cleaning method, the normal cleaning method resumes. Thus the change of inclination can be associated with one or several condition(s), for example one or several delays or a maximum threshold for frequency of changes of inclination or other, making it possible to avoid either the device only executing specific cleaning methods or have it so that the device essentially cleans the dirtiest concave junction zones. The control logic

can also be adapted to perform an effective cleaning of the concave junction zones formed by stair steps.

Advantageously and according to the invention, since the device comprises at least one inclination sensor suitable for changing state when the device's inclination relative to the horizontal passes through a predetermined reference angle value, and since the electronic controls for the motors are adapted to be able to control a reversal of the direction of the motors driving the drive units, the specific cleaning method includes the following step:

(1) after detection of the state change of at least one inclination sensor, a reversal of the direction of the motors driving the drive units is ordered.

In a first implementation variant conforming to the invention, the device comprises a single inclination sensor; the specific cleaning method includes the following step after step (1):

(2) after a predetermined period of time t_1, a new reversal of the direction of the motors driving the drive units is ordered, where the value of this predetermined period of time t_1 is sufficiently significant to allow the passage of the device from one portion of the submerged surface to the other (meaning its return to the portion of the surface on which it was initially moving), but sufficiently short so that said new reversal of drive direction has the effect of again directing the device towards said junction zone.

Advantageously and according to the invention, a delay of length t_1 is begun during the step (1).

Advantageously and according to the invention t_1 is less than 10 seconds and in particular is between two seconds and four seconds.

In a second implementation variant of the invention, the device includes:

– at least a first inclination sensor suited to detect the device's movement on one of said surface portions referred to as the first portion,

– at least a second inclination sensor suited to detect the device's movement on the second surface portion, the specific cleaning method including the following steps:

(1') with the device initially moving on the first surface portion, after detection of the state change of the second inclination sensor(s) (corresponding to its transition onto the second surface portion), a first reversal of the direction of the motors driving the drive units is ordered,

(2') and then, after detection of the state change of the first inclination sensor(s) (corresponding to its transition on the first surface portion), a second reversal of the direction of the motors driving the drive units is ordered.

According to an advantageous implementation method, the execution of the specific cleaning method is ordered upon each detection of a transition of the cleaning device from a horizontal surface portion onto a wall inclined at an angle relative to said horizontal portion greater than or equal to the inclination sensor's reference angle.

In particular, advantageously and according to the invention, at least one inclination sensor is suited for changing state when the device's inclination relative to the horizontal exceeds a reference angle value of order 60°.

Further, according to the invention, each specific cleaning method for a junction zone is begun upon delivery of the state change signal from at least one inclination sensor, meaning an electric value directly accessible on an input port of the electronic control microprocessor with which current classical cleaning devices are classically equipped. This management therefore only requires a transformation of the operation of the electronic control means to

program these latter in a manner that they order a specific cleaning method upon a state change of the inclination sensor representative of a transition of the device between contiguous walls.

By using an inclination sensor having a reference angle perceptibly greater than 45°, for example of order 60° relative to the horizontal, making it possible to determine the presence of the device on a vertical wall, the specific cleaning method is only begun upon transition of the device between a bottom wall and a side wall of the pool (or inversely); the presence of other walls inclined relative to the bottom wall, for example if there is a diving well, therefore does not operate the specific cleaning method. All the same, if the device is also provided with an inclination sensor having a reference angle relative to the horizontal perceptibly less than the minimum angle of inclination of the portions of the submerged surface walls, for example of order 20° detecting its presence on the horizontal bottom wall, the specific cleaning method can be begun upon passage between the horizontal bottom wall and the wall inclined at less than 90° relative to the horizontal, for example, inclined between 20° and 60° relative to the horizontal such as a diving well's bottom wall.

Advantageously and according to the invention, the steps (1) and (2), or the steps (1') and (2') are repeated at least once.

As a variant, advantageously and according to the invention, the steps (1) and (2), or the steps (1') and (2') are executed a single time during each specific cleaning method.

The invention extends to a device implementing the method according to the invention. The invention relates to an automatic cleaning device for a surface submerged in a liquid comprising:

- a chassis carrying a device for filtration of the liquid
- units for driving the chassis on the surface to be cleaned

– motors born on the chassis and arranged for transmitting motor movement to at least one part of the drive units

– electric means for controlling the motors

wherein

– it comprises at least one sensor (19) of the device's inclination suited for detecting changes of the device's inclination corresponding to its passage over a concave junction zone between two portions of the submerged surface inclined relative to each other.

– the electronic control means are suited for beginning between two portions of the submerged surface inclined relative to each other a cleaning method specific to the junction zone

Advantageously, a device according to the invention is also characterized by some or all of the following properties:

– the electronic control means are suited for said specific cleaning method comprising at least two reversals of the device's drive direction, with a least one reversal on each surface portion, such that the device passes over said concave junction zone from one portion of the submerged surface to the other at least three times

– it includes at least one inclination sensor suited to changing state when the device's inclination relative to the horizontal passes through a predetermined reference angle value

– the electronic control means are suited for being able to control, after detecting a change of state of at least one inclination sensor, during the specific cleaning method, a step (1) of reversing the direction of the motors driving the drive units

– it includes a single inclination sensor

– the electronic control means are suited for ordering a step (2) of again reversing the direction of the motors driving the drive units subsequent to step (1) and after a predetermined time t_1,

where the value of the predetermined time period t_1 is sufficiently large to allow the passage of the device from one portion of the submerged surface to the other, but sufficiently short so that said new reversal of drive direction has the effect of again directing the device towards said junction zone

– the electronic control means comprise a time delay of measure t_1

– it comprises least a first inclination sensor suited to detect the device's movement on one of said surface portions referred to as the first portion, at least a second inclination sensor suited for detecting the device's movement on the second surface portion, and the electronic control means suited for, during the specific cleaning method:

• the device initially moving on the first surface portion, after detection of a state change of the second inclination sensor (corresponding to its transition on the second surface portion), ordering a first step (1') of reversal of the direction of the motors driving the drive units

• and then, after detection of a state change of the first inclination sensor (corresponding to its transition on the first surface portion), ordering a second step (2') of reversal of the direction of the motors driving the drive units

– it includes at least one inclination sensor suited for changing state when the device's inclination relative to the horizontal exceeds a reference angle value of order 60°

– the electronic control means are suited for repeating at least once the steps (1) and (2), or the steps (1') and (2')

– the electronic control means are adapted so that during each specific cleaning method, the steps (1) and (2), or the steps (1') and (2')are executed a single time

The invention also relates to a method and a device characterized in combination for all or part of the properties mentioned above or below.

Other properties, goals and advantages of the invention will emerge from the following description which references the attached drawings which represent as a nonlimiting example of a device conforming to the invention; in these drawings:

– Figure 1 is a cross-section through a longitudinal axial plane AA of the cleaning device according to the invention.

– Figure 2 is a cross-section by a transverse plane BB.

– Figure 3 is a schematic view of an inclination sensor with which a cleaning device according to the invention is equipped.

– And, Figure 4 is a drawing representing the progressive steps of the cleaning method conforming to the invention.

The device shown in Figures 1 and 2 as an example is made up of a chassis formed by a body 25 open at its base, where this latter is fitted with a blocking plate 26 provided with inlets 27 for aspiration of the liquid in the area of the surface to be cleaned.

The body 25 is provided in its upper part with an outlet 3 for discharge, located opposite from the base of said body in a manner to discharge the liquid along a direction orthogonal to it.

The body 25 is internally equipped with a sealed housing 4 which is located inside the body along its transverse axis as shown in the figures.

This body 25 forms around this housing 4 a filtration chamber 4a equipped with a supple filtration bag 5 which is anchored to the base of the body on the edge of the plate 26. This bag is formed by a membrane of a supple mesh or knit material that is well known.

Further, the housing 4 contains both an electric pump motor 6 placed in its central zone, and also

a reversible direct-current drive-motor 7 placed in a transversely off-center position relative to the central zone.

The pump motor 6 drives by means of a shaft 8 a propeller or an axial pump 9 inserted in the outlet 3 which is provided with a sleeve 10 for guiding the flow.

The direct-current drive-motor 7 drives by means of a shaft 11 a transmission wheel 12 which is connected by rubber pulleys 13 to two wheels such as 14, placed at both longitudinal ends of the body.

Each of these wheels drives a transversal cylindrical roller 15 fitted with a supple sleeve of cellular polyurethane foam 16. The two sleeves 16 are arranged to come in contact with the submerged surface and fill the double function consisting of producing a movement of the device in one direction or the other according to the direction of rotation of the motor 7, and of performing a brushing of the surface tending to loosen its impurities or deposits which are next aspirated into the filtration chamber 4a through the inlets 27 under the effect of the pump 9.

Further a floater 17 formed by a hollow cylinder above the body 25 is hinged on its sides in a transverse plane. This floater which can contain a mobile weight such as a lead ball cooperates with the off-center motor 7 to unbalance the device when it's in the area of the water level; it therefore produces a lateral movement of the device along this line. The floater 17 is also used for grasping the device during handling.

The cleaning device according to the invention further includes a classically programmed electronic card 18 with microprocessor(s), in the first place for managing the operation of this device and, for example such as described in the patent FR 2,567,552, for commanding the execution of standard cleaning programs during which periodic stoppages of the pump 6 and periodic reversals of the drive motor 7 are combined.

This cleaning device includes, in the housing 4 an inclination sensor 19 suited for changing state during a transition of this device

between two walls inclined relative to each other at an angle greater than or equal to 60°, and more specifically in the context of a swimming pool, during the transition between a horizontal bottom wall 31 and a lateral vertical wall 30 of this pool.

As shown schematically in Figure 3, this inclination sensor 19 includes a hollow box 20 provided with a cylindrically shaped upper trunk 20a extending from a lower trunk 20b which has a truncated-cone shape and a summit angle equal to 60°. The wall of the hollow box 20 is made of electrically conducting material and is connected to the ground of the electronic card 18.

This box 20 encloses a ball 21 also of electrically conducting material lodged in the lower trunk 20b of said box, along with an electric contact wire 22 extending axially in the upper trunk 20a in a manner that a connection between the ball 21 and the electric contract 22 is established when the sensor 19 is inclined at an angle greater than or equal to 60° relative to its initial horizontal position shown in Figure 3.

As shown in Figure 1, the box 20 of the sensor 19 is attached overall vertically, in its position shown in Figure 3, to a wall of the body 25 of the cleaning device. Thus, when this cleaning device is horizontal, the sensor 19 is in the position shown in Figure 3. When the cleaning device reaches an inclination at an angle greater than about 60° relative to the horizontal, the ball 21 comes in electrical contact with the end of the wire element 22 which it therefore connects to the ground of the electronic card 18. Further the wire element 22 is also connected to the electronic card 18 such that this contact of the ball 21 with this wire element produces a signal representing a change of state of the inclination sensor 19.

This change in state for example occurs when the cleaning device's forward roller reaches the height (a) shown in Figure 4 on the lateral wall 30 (while coming from the bottom wall 31).

According to the invention and as shown schematically in Figure 4, the electronic card at 18 is programmed so that during a change of state of the inclination sensor 19 representing the transition of the cleaning device between the

bottom wall 31 and a lateral wall 30 of the pool, it begins a specific cleaning method for the concave junction between the walls 30 and 31 consisting of:

– stopping the motor 7 and therefore the cleaning device's forward motion, then ordering the reversal of the motor 7 so as to cause a displacement of the cleaning device in the direction opposite to its initial displacement direction during a period t_1 of order two to four seconds, suited for causing a return and a displacement of this device on the bottom wall 31 of the pool, for example up to the position (b) shown in Figure 4 and

– again stopping the motor 7, then again reversing the motor 7 after the period of time t_1 so as to reengage the cycle of classical progression ordered by the cleaning device's operation program by displacing along the arrow (c) shown in Figure 4

Further, advantageously, and in order to minimize the loss of time arising from the implementation of the specific cleaning method, the progress of the device is stopped nearly immediately after the detection of the state change of the sensor 19 (when the device reaches a predetermined height on the lateral wall 30, for example the height (a) shown in Figure 4). Further, a timer is begun by the electronic card 18 upon receiving the state change signal from the sensor 19 for counting down the period t_1.

The step of reversing the direction of the drive motor can be repeated several times, for example with a number of iterations included between two and 20. On the other hand, it can be executed only a single time for having the cleaning device perform only one simple back-and-forth at the foot of the wall. In any case, at the end of the specific cleaning method, it is advantageous that the cleaning device continue its normal initial displacement, meaning in the examples cited above continue climbing the vertical lateral wall 30 beyond the height (a). To do this, the electronic card 18 is advantageously adapted to begin a new timer for period of time t_2 for example of order 15 to 60 seconds, for commanding the climbing of the cleaning device

up to the pool's waterline, and beginning that from the beginning of the last step where the direction of the drive motor 7 was again ordered in the direction of the initial displacement.

It should also be noted that the invention is also fully applicable to a different type of cleaning device than that shown in the figures, once it is possible to order a reversal of this device's drive direction in a logical manner. It could therefore also be applicable to other devices than those with electric motor(s). In the same manner it is also applicable to a cleaning device comprising several electric drive motors for example as described in FR 2,818,680.

It should also be noted that the specific cleaning method can be started not only upon passage from the bottom wall 31 towards a vertical lateral wall 30, but in contrast upon passage in the opposite direction when the cleaning device descends a lateral vertical wall 30 to move onto the horizontal bottom 31.

Also, in place of the time delay for a period of time t_1 begun to assure the cleaning device returns to the surface portion on which it was initially, several inclination sensors can be used. For example, the cleaning device can be provided with two inclination sensors such as 19 with one mounted vertically as described above, the other horizontally.

This second sensor mounted horizontally will only provide a signal to the electronic card 18 when the cleaning device moves at least noticeably horizontally on the bottom wall 31 (with an inclination, in the example given, less than 30° relative to the horizontal). Once it leaves this bottom wall and its inclination is greater than for example 30° relative to the horizontal, the second inclination sensor will change state. Based on two signals provided by such inclination sensors, the electronic card 18 can easily be programmed to assure back and forth displacements at the junction zone between the two walls 30 and 31 or two other walls with different inclinations. The angle of the cone for the second inclination sensor can

be chosen with a different value to provide a sensor reference value different than 30°, for example of order 20°. This value must be less than the smallest inclination relative to the horizontal of the submerge surface's non-horizontal walls. Thus, this second sensor makes it possible to detect the device's presence on the horizontal portion of the wall.

Further, a double sensor (two cones and two balls) or two horizontal sensors mounted head to tail and connected to the card 18 in parallel can be used to be able to detect changes to the device's inclination in both directions of displacement.

For example, with the device initially on the horizontal bottom wall 31:

– when the first vertical sensor changes state, thereby detecting the device's passage onto a vertical lateral wall 30, the motor(s) 7 is stopped and with it the device's progress, then to drive motor(s) 7 is reversed for as long as the second inclination sensor does not change state

– and, when the first sensor returns to its initial state (the device is not on the vertical lateral wall 30) and the second sensor returns to its initial state (the device is on the horizontal bottom wall 31), the motor(s) 7 is again stopped, and the motor(s) 7 is again reversed in order to next either repeat these steps several times or reengage the standard cleaning method.

It is also possible, as a variant, to use other types of inclination sensors than those described above and shown in the figures and/or other programmed command logic in the electronic card 18, notably depending on the values of the reference angles (triggering thresholds) chosen for the sensors. For example, it is possible to use digital inclination sensors offering one or several triggering thresholds. It is possible to provide as many sensors or trigger threshold values (possibly adjustable) as there are inclination values relative to horizontal as there are surface portions.

Also nothing prevents combining different control logics, for example one control logic with a single sensor and time delay for cleaning the concave junction zones between the vertical walls and the horizontal bottom, and a control logic with two sensors for cleaning the concave junction zones between the bottom walls and walls slightly inclined relative to the horizontal (for example diving well).

In any case, the invention consists essentially in having automatic back-and-forth displacements done in the concave junction zone between walls of different inclinations such as 30 and 31 in order to improve the cleaning of this concave junction zone resulting from repetitive passages of the cleaning device over this zone.

The cleaning device according to the invention is therefore designed, by means of a minor modification to efficiently assure the cleaning pool surface portions at the foot of the lateral walls of these pools.